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PATENT & TRADEMARK OFFICE

ATTACHMENT B

Amendments to the Specification

Please replace the Title on page 1 (lines, with the following amended Title:

~~SYNTHETIC DOPPLER~~ SYSTEM AND METHOD FOR LOCATING COOPERATIVE TRANSCEIVERS WITH VALIDATION THROUGH CLASSIFICATION OF DIRECT AND REFLECTED SIGNALS

Please replace the paragraph at page 1, lines 12-15, with the following amended paragraph:

The present invention relates generally to a system and a method to determine an accurate location of co-operative transceivers in indoor locations and, in particular, to use synthetic Doppler shift, in conjunction with time-of-arrival/time-difference-of-arrival information, to distinguish between a line-of-sight received signal from multiple external transmitting beacons and a reflected received signal.

Please replace the paragraph at page 1, lines 20-25, with the following amended paragraph:

In all forms of geolocation, either indoor or outdoor, there are no known effective techniques at present to determine if a ~~first arrived~~first-to-arrive signal reaching a receiver is a line-of-sight signal or a reflected received signal, i.e. one having one or more reflections from surfaces. This causes a substantial deterioration of the geolocation results since it is impossible to determine if the calculated location is derived from valid line-of-sight signals or from erroneous data originating from reflected received signals.

Please replace the paragraph bridging pages 1 and 2 (page 1, line 26 to page 2, line 2), with the following amended paragraph:

The accurate location of co-operative transceivers in indoor locations is required in applications such as firefighting. The main challenge for such systems is created by attenuation and reflections formed by the presence of interior and exterior walls as well

as floors in multi-story buildings. Although some mitigation of the effects created by the presence of reflected received signals is possible by using techniques such as spatial filtering or other sophisticated signal processing techniques, no effective technique has existed up to present to determine if the ~~first received~~first-to-arrive signal is a line-of-sight or a reflected one.

Please replace the paragraph at page 2, lines 9-30, with the following amended paragraph:

According to one aspect of the invention a transceiver located in an enclosed location wirelessly receives and measures time-of-arrival or time-difference-of-arrival of a first-to-arrive signal originating from each of two or more revolving wireless transmitters generating and transmitting a synthetic Doppler shift signal situated outside the enclosed location and ~~relays~~forwards those measurements ~~wirelessly~~ to a processing ~~centre~~means. The transceiver also determines the angle-of-transmission of a transmitter for a first-to arrive signal from each transmitter, wherein such signals are the only ones with the potential to be line-of-sight signals, as well as angles-of-transmission for any other arriving reflected signals reflected by any reflecting surfaces in the enclosed location and ~~relays~~forwards all of those measurements to a processing ~~centre~~means via the transceiver. The processing ~~centre~~means computes a line-of-position from the times-of-arrival or time differences-of-arrival from the first-to-arrive signal from each transmitter. The location of the transceiver is determined as the intersection of the line-of-position with the intersection point of the angles-of-transmission, if the line-of-position intersects with the intersection point of the angles-of-transmission, or if no such intersection occurs, the location of the transceiver is determined through an iterative trial and error process that employs the correct angles-of-transmission, knowledge of the location of reflecting surfaces situated within the enclosed location and time-of-arrival or time-difference-of arrival data assuming various angles of reflection to account for the positions of the known reflecting surfaces, until the times-of-arrival or time-differences of arrival calculated using this method are the same as the times-of-arrival or time-differences of arrival calculated from the signals detected by the transceiver.

Please replace the paragraph at page 3, lines 16-19, with the following amended paragraph:

Figure 3a illustrates the determination of the angle-of-transmission by simultaneously modulating a carrier with a short spreading code and revolving a transmitting antenna about a horizontal circle to create a synthetic Doppler shift illustrated in Figure 3b, and

Please replace the paragraph bridging pages 3 and 4 (page 3, line 27 to page 4, line 2), with the following amended paragraph:

In all forms of geolocation, either indoor or outdoor, there are no known effective techniques at present to determine if a ~~first arrived~~first-to-arrive signal reaching a receiver is an actual line-of-sight signal or a reflected one, i.e. one having one or more reflections from surfaces. This causes a substantial deterioration of the calculated geolocation results since it is impossible to determine if the calculated location is derived from valid line-of-sight signals or from erroneous data originating from reflected received signals.

Please replace the paragraph at page 4, lines 3-10, with the following amended paragraph:

The accurate location of co-operative transceivers in indoor locations is required in applications such as firefighting. The main challenge for such systems is created by attenuation and reflections formed by the presence of interior and exterior walls as well as floors in multi-story buildings. Although some mitigation of the effects created by the presence of reflected received signals is possible by using techniques such as spatial filtering or other sophisticated signal processing techniques, no effective techniques exists up to present to determine if the ~~first received~~first-to-arrive signal is a line-of-sight or a reflected one.

Please replace the paragraph at page 4, lines 19-28, with the following amended paragraph:

In a co-operative scenario, multiple transmitting beacons 1, 2 and 3 are set up outside a building 10, within which it is desired to track a transceiver's movements as illustrated in Figure 1. Each transmitter transmits a short spreading code signal. The period of spreading code is arranged in such a way to have a relationship with the time for revolution of antenna on the transmitter as discussed below. The time-of-arrival (TOA) or time-difference-of-arrival (TDOA) of the first-to-arrive signal can be determined by a search correlator processing ~~a direct sequence~~the spreading code. It is also possible to evaluate the angle-of-transmission (AOT) from a beacon associated with a particular reflected path by using Doppler techniques. The AOT and either the TOA or TDOA of the first-to-arrive signal originating from the external beacons measured by the mobile transceiver are ~~relayed back~~forwarded to a processing centre to determine the location of the mobile transceiver from that data.

Please replace the paragraph bridging pages 4 and 5 (page 4, line 29 to page 5, line 9), with the following amended paragraph:

Figure 2 illustrates how the AOT is used with the TOA or TDOA information 30 to determine the validity of an apparent location of a mobile transceiver 8 or to determine the actual location of the mobile transceiver 7. A line-of-position is computed from the TOA or TDOA of the first-to-arrive signal from each transmitter. If the AOTs ~~intersect~~intersection point is on the line-of-position, then a direct path has been achieved, i.e. the one between transmitter beacon 6 and the actual location of mobile transceiver 7. If the AOTs ~~do not intersect~~intersection point is not on the line-of-position, then a reflection has occurred and an invalid computed location 8 results. This is illustrated by the path from transmitting beacon 5 reflecting from wall 4 to the actual location of the mobile transceiver 7, which results in a longer path between 5 and 7. Without the AOT information, the apparent location of the mobile transceiver would then be somewhere around 8.

Please replace the paragraphs at page 5, lines 10-26, with the following amended paragraphs:

The AOT to different observers at 27 and 28 in Figure 3a can be provided by simultaneously modulating a carrier with a short spreading code and revolving the transmitting antenna about a horizontal circle such that the position of the transmitting antenna moves around the circle from position 21 to 26 and back to 21 in Figure 3a at various points in time. This creates a synthetic Doppler shift wherein the AOTs of observers 27 and 28 in Figure 3a correspond to frequencies 30 and 31, in Figure 3b, respectively. The period of the short spreading code and the time for one revolution are integrally related. The simplest relationship is to have them be equal. The instantaneous Doppler shift on the transmitted signal will be different for all AOTs but the instantaneous code phase will be identical.

A reference direction can be established at the transmitter based on a relationship between the code epoch and the reference Doppler shift. For example, the start of the code sequence (code epoch) and the maximum positive Doppler shift can be set to occur simultaneously for a specified direction. For all other directions, the time of occurrence of the code epoch and the maximum positive Doppler shift will differ. This time difference (phase difference) is directly proportional to the angle offset or AOT with respect to the reference direction.

Please replace the paragraph at page 6, lines 20-21, with the following amended paragraph:

For the synthetic Doppler shift, the instantaneous radian-frequency of a signal that has sinusoidal frequency modulation applied to it is given by:

Please replace the paragraph at page 7, lines 2-4, with the following amended paragraph:

When the sinusoidal frequency modulation is generated, by revolving a transmitting antenna about a vertical axis, i.e. in a circle to create Doppler ~~shifts~~shift, the signal will include an azimuth dependent term:

Please replace the paragraph at page 8, lines 9-15, with the following amended paragraph:

The FM carrier is then demodulated in a phase locked discriminator (FM demodulator 42) producing a baseband-sinusoid that corresponds to the instantaneous synthetic Doppler shift on the radio carrier. The positive zero crossings of the baseband-sinusoid are converted to a pulse-train at 43 and the time difference between the pulses of the pulse-train and those of the code-epoch pulse-train obtained at 44 yields the angle-of-transmission information. This information can be computed in a processor or determined with analog circuits.